Design and Development of Open Source Based Interactive e-Waste Management System

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Abstract—**e-Waste has become an issue of serious concern to environmentalists. e-Waste is a complex mixture of hazardous and non-hazardous waste, which consists of items of economic value. Therefore, it requires specialized segregation, collection, transportation, treatment, disposal and recycling. 'e-Waste' is a popular, informal name for electronic products nearing the end of their useful life. e-Wastes are considered dangerous, as certain components of some electronic products contain materials that are hazardous, depending on their condition and density. The hazardous content of these materials pose a threat to human health and environment. Discarded computers, cell phones, televisions, batteries and other electronic materials if improperly disposed can leak out lead and other substances into soil and groundwater. Many of these products can be reused, refurbished, or recycled in an environmental friendly manner so that they are less harmful to the ecosystem. It is a "reverse production" system that designs infrastructure to recover and reuse every material contained within e-Wastes metals such as lead, copper, aluminum, iron, silica , etc and non-metals such as rubber, sulfur, etc. This research work highlights the hazards of e-Wastes, the need for its appropriate management and options that can be implemented and it also assist in understanding, planning, designing and implementing e-Waste take-back schemes for use by cities or other localized areas or for use at a nation-wide level.**

Keyword: **e-Waste Management System, Recycling, Reuse, Responsibilities, Challenges, e-Waste Rules.**

I, INTRODUCTION

This research work highlights the hazards of e-Wastes, the need for its appropriate management and options that can be implemented and it also assist in understanding, planning, designing and implementing e-Waste take-back schemes for use by cities or other localized areas or for use at a nation-wide level. This research work helps to make an online system for sellers, buyers and recyclers for managing the e-Waste globally. The various companies currently involved in the recycling of electronic products are Cimelia (Singapore), Lifespan technologies (U.S.), Intercon Solutions etc.
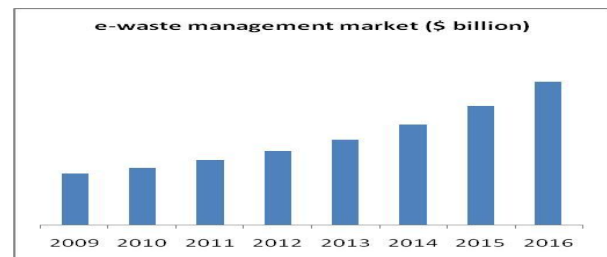
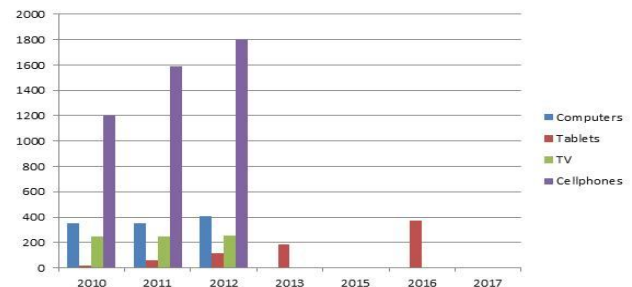Fig 1: e-Waste management market

Fig 2: Widely use of Electronics equipments

A. High Level e-Waste Management Challenges

The main high level challenges that need to be addressed in managing e-Waste and other countries around the world, can be summarized as:

1. How to reduce the hazardous substance content of electrical and electronic products.

2. How to reduce levels of unsafe disposal and processing of e-Waste and increase levels of reuse, recycling and recovery ("the three "Rs"). Meeting these challenges is likely to require a number of inter-related measures, including:

- Promotion of environmentally friendly e-product design
- Enforcement of national and international legislation on export and disposal of hazardous waste
- Development and enforcement of e-Waste management legislation and regulations
- Education and awareness raising
- Co-operation and compliance of producers
- Establishment of efficient and effective e-Waste
- Awareness of disposal of e-Waste

B. e-Waste (Management & Handling) Rules, 2011:

The e-Waste (Management & Handling) Rules, 2011 have been notified in May 2011 and will be effective from 01-05-2012. These rules shall apply to every producer, consumer or bulk consumer. Collection centre, dismantler and recycler of e-Waste involved in the manufacture, sale, purchase and processing of electrical and electronic equipment or components as specified in schedule – the regulatory agencies involved are SPCBs/PCCs and CPCB.

C. Management of e-Waste:

It is estimated that 75% of electronic items are stored due to uncertainty of how to manage it. These electronic junks lie unattended in houses, offices, Warehouses etc. and normally mixed with household wastes, which is finally disposed off at landfills. This necessitates implement able management measures.

Table 1: General Test Scenario of e-Waste Management System

S.No.	Input	Steps	Expected Result
1	Insertion of e-Waste material	-Go to NGOs - Return to particular company - Recycler company	-proper management of e-Waste

D. Purpose of e-Waste Management System:

The electrical and electronic equipment (EEE) have valuable materials and hazardous/toxics substances in their components. The electronic products and electrical equipment after their useful life may not cause any harm if it is stored safely in households/stores. However, if the E-Waste is opened-up and attempts are made for retrieval of useful components or material in an un-scientific manner or if the material is disposed in open, then it may cause health risks and damage to environment. E-Waste can be considered as a resource that contains useful material of economic benefit for recovery of plastics, iron, glass, aluminum, copper and precious metals such as silver, gold, platinum, and palladium and lead, cadmium, mercury etc. However, at the same time presence of heavy metals (As, Cd, Hg, Pb etc.) and other toxic substances such as polychlorinated bi-phenyls (PCBs), etched chemicals, etc. may pose risk to health and environment during handling and recovery operations. E-Waste is a problem of increasing proportions especially when crude methods are adopted for recovery of useful components from E-Waste. There is a need to encourage recycling of all useful and valuable material from e-Waste so as to conserve the ever depleting natural resources. Electronic component are increasingly made from recycled materials

II. MAJOR STAKEHOLDERS

A. Producer: is any person who, irrespective of the selling technique used; "manufactures and offers to sell electrical and electronic equipment under his own brand; or offers to sell under his own brand, assembled electrical and electronic equipment produced by other manufacturers or suppliers; or offers to sell imported electrical and electronic equipment" has to take authorization under these Rules for implementation of EPR.

B. Bulk Consumers: are bulk users of electrical and electronic equipment such as central government or state government departments, public sector undertakings, banks, educational institutions, multinational organizations, international agencies and private companies that are registered under the Factories Act, 1948 and Companies Act, 1956; who has to maintain records on E-Waste generated and channelized to registered / authorized collection centres /recycler/ dismantler.

C. Extended Producer Responsibility: is a responsibility of any producer of electrical or electronic equipment, for their products beyond manufacturing until environmentally sound management of their end of life products, the scope of which has to be clearly defined while issuing authorization to individual producers.

D. Collection Centre: is a centre established individually or jointly or a registered society or a designated agency or a company or an association to collect e-Waste who has to obtain authorization under E-Waste Rules, 2011.

E. Dismantler: is any person or registered society or a designated agency or a company or an association engaged in dismantling of used electrical and electronic equipment into their components who has to obtain authorization and registration under HW (M, H&TM) Rules 2008 /E-Waste Rules, 2011.

F. Recycler: is any person who is engaged in recycling or reprocessing of used electrical and electronic equipment or assemblies or their component, who has to obtain authorization and registration under HW (M, H &TM) Rules 2008 /E-Waste Rules, 2011.

G. SPCBs/PCCs: They have been given the responsibility as regulatory agencies for implementing the E-Waste Rules in respective States

H. CPCB: was given the responsibility to evolve the guidelines for implementation, oversee the progress made in implementing the Rules and also to implement RoHSS compliance.

III. METHODOLOGY

- Workshop on awareness on disposal of e-Waste
- Awareness on need for a global agreement to address the problems and challenges posted by hazardous waste
- Development of online e-Waste Management System for proper disposal of e-Waste.
- Prevention of Electronic waste
- Making an responsibility for Costumer, User, Recycler and Industries manager.
- Increasing the collection centers

A. A New Opportunity for Waste Prevention, Reuse, and Recycling

Research completed in Europe shows that electronics waste is growing at three times the rate of other municipal waste. To the extent possible, electronics waste should be prevented, and older electronics should be reused and recycled.

This system provides information on ways you can reduce the environmental impact of electronics use and disposal through reuse, donation, recycling, and buying greener electronic products.

This system provides waste management options including Recycling, Donating electronics for reuse. By donating your used electronics, you allow schools, non-profit organizations, and lower-income families to use equipment that they otherwise could not afford.

Companies and governmental organizations can encourage electronics manufacturers to design greener electronics by purchasing computers and other electronics with environmentally preferable attributes and by requesting takeback options at the time of purchase.

If donation for reuse or repair is not a viable option, households and businesses can send their used electronics for recycling. Recycling electronics avoids pollution and the need to extract valuable and limited virgin resources. It also reduces the energy used in new product manufacturing.

B. Facility and Services provided by System

E-Management System provide services such as

- For General User :
  Application For Obtaining Authorization For Generation / Collection/Storage/Dismantling / Recycling / Of E-Waste
- Name , Full address with email, contact no, type of user.
- Processing or generation of e-Waste.
- E-Waste Details such as
  Type of e-Wastes generated as defined under the e-Wastes (Management and Handling) Rules, 2011, Total Quantity e-Waste handled, generated/collected/dismantled/recycled, Mode of storage within the plant, Method of treatment and disposal, Installed capacity of the plant
- For Recycler and Dismantling:
  Detailed proposal of the facility (to be attached) to include:
  (i) Location of site (provide map).
  (ii) Details of processing technology
  (iii) Type and Quantity of waste to be processed per day
  (iv) Site clearance (from local authority, if any)
  (v) Utilization of the e-Waste processed
  (vi) Method of disposal of residues (details to be given)
  (vii) Quantity of wastes to be processed or disposed per day
  (viii) Details of categories of e-Waste to be dismantled/processed
  (ix) Methodology and operational details

(x) Measures to be taken for prevention and control of environmental pollution including treatment of leachates

(xi) Measure to be taken for safety of workers working in the plant

- Maintaining Records Of E-Waste Handled/ Generated (Quantity in Metric Tonnes (MT) or Kilograms (Kg) per year)

C. Working on e-Waste

EPA's goal is to promote greater product stewardship of electronics. Product stewardship means that all who make, distribute, use, and dispose of products share responsibility for reducing the environmental impact of those products. We intend to work towards this goal in three ways:

- increase reuse and recycling of used electronics,
- ensure that management of electronics is safe and environmentally sound, and 3) foster a life-cycle approach to product stewardship, including environmentally conscious design, manufacturing, and toxics reduction for new electronic products. EPA is currently working with stakeholders in both the public and private sectors to meet these goals. In support of these efforts, EPA will be looking to streamline regulations and policies. We aim to make it easier and more cost-effective for consumers, retailers, recyclers, manufacturers, and governments at all levels to help divert these products into environmentally sound reuse and recycling, as well as reduce the environmental footprint of electronic product use.

D. Organizations

EPA's Product Stewardship Program
EPA's Product Stewardship program encourages more environmentally sustainable management of a variety of products, including electronics. Visit the program's web site for information about electronics stewardship projects that are occurring across the country.

Electronic Industries Alliance (EIA)
A trade association for the electronics industry. The EIA web site maintains information on what member companies are doing to incorporate environmental attributes into electronic products.

International Association of Electronics Recyclers (IAER)
A non-profit trade organization that supports the electronics recycling industry. The IAER web site provides information on industry trends and a database of commercial electronics recyclers.

National Recycling Coalition (NRC)
A non-profit group dedicated to advancing recycling and source reduction. NRC's Electronics Recycling Initiative web site contains information on procurement and other electronics recycling issues.

Polymer Alliance Zone (PAZ)
A public-private partnership that is developing a regional

center for electronics recycling in West Virginia. Visit the PAZ web site to learn more about this innovative project.

Silicon Valley Toxics Coalition (SVTC)

A grassroots coalition that performs research and advocacy on environmental and human health issues related to electronics. The SVTC web site includes a report on toxics in electronics waste and an analysis of the environmental performance of electronics manufacturers based on web site information.

IV. FUTURE ENHANCEMENT

According to the Toxics Link, the import of e-Waste should not be allowed as we currently do not have the infrastructure to even deal with the domestically generated e-Waste. It would only lead to the country becoming a waste dump of the globe with serious health and environment impacts. Yet, there are others who call for adequate safeguards to restrict the import of used electrical and electronic equipment in the country and ensure that imported wastes are reprocessed by the companies under license to import e-Waste and not re-sold again.

As per the Exim Policy of Ministry of Commerce's (Handbook of Procedures Vol. 1 2009-14), import of second hand computers including personal computers/laptops and refurbished/reconditioned spares is restricted. However, the import of second hand computers including personal computers/laptops and computer peripherals including printers, plotters, scanner, monitor, keyboards and storage units as donations by certain categories of donors was permitted earlier. Directorate General Foreign Trade (DGFT) published a Public Notice dated 13.5.2010, wherein this provision has been deleted. 191 As per The Hazardous Wastes Rules, 2008, units involved in e-Waste recycling are required to obtain authorization and registration from the State Pollution Control Board concerned. Directions have been issued to all Central/State Government to handover e-Waste generated in their premises to authorized and registered recyclers.

V. RESPONSIBILITIES

- **Responsibilities of the Government:**
Governments should set up regulatory agencies in each district, which are vested with the responsibility of co-ordinating and consolidating the regulatory functions of the various government authorities regarding hazardous substances.

- **Responsibility and Role of industries:**
Generators of wastes should take responsibility to determine the output characteristics of wastes and if hazardous, should provide management options.

- **Responsibilities of the Citizen:**
Waste prevention is perhaps more preferred to any other waste management option including recycling. Donating electronics for reuse extends the lives of valuable products and keeps them out of the waste management system for a longer time. But care should be taken while donating such items i.e. the items should be in working condition.

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ABBREVIATIONS AND ACRONYMS

CPCB - Central Pollution Control Board
SPCB - State Pollution Control Board
PCC - Pollution Control Committees
EEE - Electrical Electronic Equipments
NGOs - Non-Governmental Organization
EPA- Environmental Protection Agency
IT& TE - Information Technology & Telecommunication Equipments
DGFT- Directorate General Foreign Trade

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